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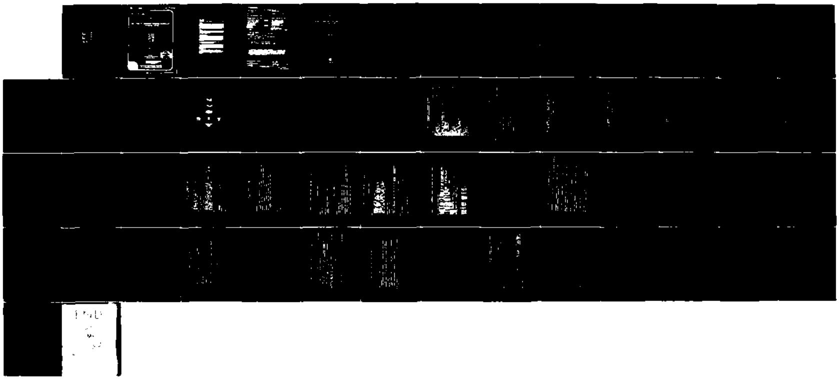

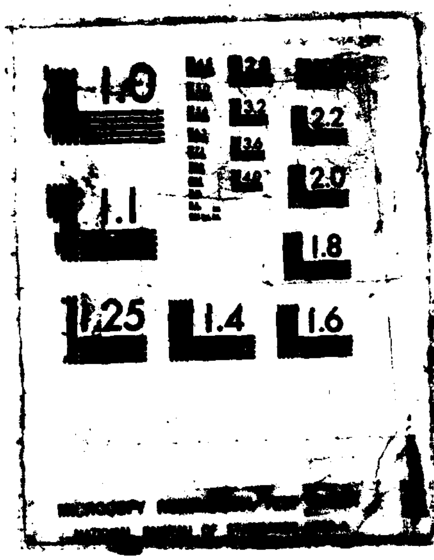
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A PROGRESS REPORT

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This report describes a methodology for examining the application of new technologies for training the Army's reserve components (Reserve and National Guard) and presents a statistical description of the environment for training Reservists and Guardsmen. For that environment, which is characterized principally by a dispersion of many small training target populations and low expected utilization of training equipment, the capabilities and costs of interactive video make such equipment especially well-suited for Army Reserve Component (RC) training. Information that is expected to be useful in further examination of Army RC training is also provided.

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ARMY RESERVE COMPONENT TRAINING TECHNOLOGY — A PROGRESS REPORT

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January 1987

INSTITUTE FOR DEFENSE ANALYSES

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FOREWORD

This document is one of four reports on work performed by the Institute for Defense Analyses for the Office of the Assistant Secretary of Defense (Reserve Affairs) since August 1985 under Task Order T-M2-266, "Reserve Component Training Technology." While the task is concerned with the reserve components (RCs) of all the Services, our effort to date has been focused on the Army Guard and the Army Reserve.

This first report, IDA Paper P-1971, (1) describes the methodology of our investigation of Army RC training, (2) presents a statistical description of the environment for that training, and (3) provides other information that we expect to be useful for our continuing look at the Army RCs.

The second report, IDA Paper P-1972, "Training State of a Group of Army Combat Service Support Units (U)," (1987), is an assessment of the state of training of Guard and Reserve units that perform combat logistics functions, i.e., maintenance and movement of equipment, supplies, and personnel; it is the only one of the four reports that is classified (confidential).

An evaluation of tank gunnery devices is described in our third report, IDA Paper P-1973, "Simulation Trainers for Tank Gunnery," (1987).

The fourth report, IDA Memorandum Report M-255, "Initial Assessment of Maintenance Training of Army Reserve Components," (1987), is a preliminary examination of Army RC maintenance training to identify area(s) for analysis.

CONTENTS

TABLES

FIGURE

ABBREVIATIONS

ARNG	Army National Guard
CAI	computer-aided instruction
CBT	computer-based training
CMF	career management field
CTEA	cost and training effectiveness analysis
EIDS	Electronic Information Delivery System
FO	forward observer
IDA	Institute for Defense Analyses
ISD	instructional system development
LCC	life cycle cost
MOS	military occupational specialty
NCO	non-commissioned officer
OASD(RA)	Office of the Assistant Secretary of Defense (Reserve Affairs)
O&S	operating and support
OSD	Office of the Secretary of Defense
PERSACS	Personnel Strength and Composition System
RC	reserve component
R&D	research and development
TDS	training development study
TOE	task of organization and equipment
TRADOC	Training and Doctrine Command
USAR	Army Reserve

SUMMARY AND DISCUSSION

The relative costs of Active forces and Reserve forces make Guard and Reserve units increasingly important in defense planning. With the inception of the Total Force policy, the training objectives of Guard and Reserve units became the same as those of Active units with similar missions. This paper is a progress report on Phase 1, Army reserve components (RCs), of a study of technology and procedures to improve training programs of the reserve components of the services. The study methodology for Phase 1 is expected to be used in subsequent phases that examine the Navy and the Air Force.

The other side of the economic coin that applies to the Reserve forces is less time and equipment than the Active forces have for training, fewer training areas, and poorer training facilities. These factors plus geographic dispersion of Guard and Reserve units make the training environment much different from that for Active forces.

The density distributions of several large-population MOSs (see Section II) illustrate quantitively a dominant characteristic of the Army RC environment: A dispersion of many small training target populations. Combined with low expected utilization of equipment (by soldiers with limited availability for training) this dispersion makes low-cost-per-trainee a design imperative for RC training devices.

Although we have developed a methodology for identifying cost-effective devices (see Fig. 1), it is too early to make investment recommendations for specific training applications. However, our investigation indicates that the capabilities and costs of interactive video make that equipment especially attractive for Army RC training. To illustrate the potential of interactive video, let's, consider some new developmental devices.

EXAMPLE: The heart of Guardfist 2, an artillery trainer in full-scale development, is a single videodisc system that provides realistic scenery, targets, and explosion graphics for the artillery forward observer to call for and adjust indirect artillery and mortar fires. Guardfist 1, a full-crew tank gunnery procedures trainer, which is also being developed, will include three videodisc systems--one each for the tank commander, the gunner, and the driver--that similarly provide realistic scene-target imagery, which can be used to depict surrogate travel and thus create simulated motion.

The M-COFT is also a tank gunnery procedures trainer, which uses computer-generated imagery. The M-COFT development was completed in 1986; its ongoing procurement implies Army satisfaction with its cost-benefit specifics. The cost and effectiveness of Guardfist 1 have not been estimated; nor has the similarity of M-COFT and Guardfist 1 been analyzed in terms of task-training capability. While many tasks may be common to both trainers, we expect that other tasks can be trained on one device but not the other.

Let's set aside for a moment the fact that we have not yet analyzed the training effectiveness of Guardfist 1 and M-COFT,[1] but use our analyses of the costs of Guardfist 2 and M-COFT. If the 3:1 ratio of the number of videodisc systems for Guardfist 1

[1] These are two of five tank gunnery simulators that were subsequently examined in IDA P-1973.

and Guardfist 2 is used as an indicator of the relative life cycle costs (LCC) of these trainers, the LCC per trainee[1] of Guardfist 1 is one-sixteenth of the LCC per trainee of M-COFT (see Section III.F.2).

[1] LCC per trainee is an average, undiscounted cost divided by the number of personnel slots (or billets), each of which is assumed filled by a soldier-trainee, in the table of organization and equipment of the unit using the device.

I. INTRODUCTION

A. BACKGROUND

Under the Department of Defense's Total Force Concept, performance standards and training objectives for Guard and Reserve units are the same as those of Active units with similar missions. However, the differences in costs of full-time and part-time forces and in opportunities for learning and practice associated with current training timetables for these forces make it necessary for the services to use different training strategies for active components and reserve components (Guard and Reserve). There is general agreement that strategies for training the reserve components (RCs) have not, in many cases, provided units with personnel trained well enough to meet their service performance standards (for example, see Ref. 1, a recent Defense Science Board report). Thus, the Office of the Assistant Secretary of Defense (Reserve Affairs) and the Institute for Defense Analyses have undertaken, in late 1985, a study of major elements of those strategies, viz., training technology and training procedures.

B. OBJECTIVES

The objectives of this OASD(RA)/IDA study are to (1) identify significant shortcomings (if any) in the use of technology, training devices, and procedures to train the RCs of all services and (2) make proposals for the development and acquisition of cost-effective training devices and procedures needed to train the RCs.

C. SCOPE

Because of particular congressional interest in nonsystem training devices[1] for the Army Guard and Reserve, the first phase of our study is concerned only with the Army RCs. In this study, "Reserve" means the Selected Reserve category of the Army's Ready Reserve; thus the Individual Ready Reserve, which consists of Ready Reservists not belonging to the Selected Reserve, is not considered.[2]

Due to time and resource constraints, our attention has been directed to the major cost elements of Army RC training. Thus, our study focuses on sustainment and unit training, vis-a-vis institutional training, and on enlisted personnel only.

This report is a prose-form version of analyses and information previously included in an OASD(RA) report to Congress on future requirements and acquisition of nonsystem training devices for the Army RCs early in 1986, when our study effort had been underway for about four months. The analyses are (1) a logical decision path for selecting training devices and procedures and (2) a statistical description of the Army RC training environment. The information presented in this report documents our data collection and evaluation efforts through early 1986 and is related to those analyses and/or is expected to be used in our future work.

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[1] A "nonsystem" device supports general military training, or more than one system or item, or several different types of equipment (an example: MILES, Multiple Integrated Laser Engagement System). A "system" device is designed for use only with a specific system or item (an example: M48 tank Turret Trainer). This study will consider both types of training devices, as appropriate.

[2] Nor are the other major categories--viz. the Standby Reserve and the Retired Reserve--of the Army Reserve considered.

D. APPROACH

Inasmuch as identifying technology and procedures to meet training needs of the service RCs means finding the most promising training investments, our study strategy involves evaluating both the effectiveness and costs of training media.[1] Our methodology is outlined in Fig. 1.

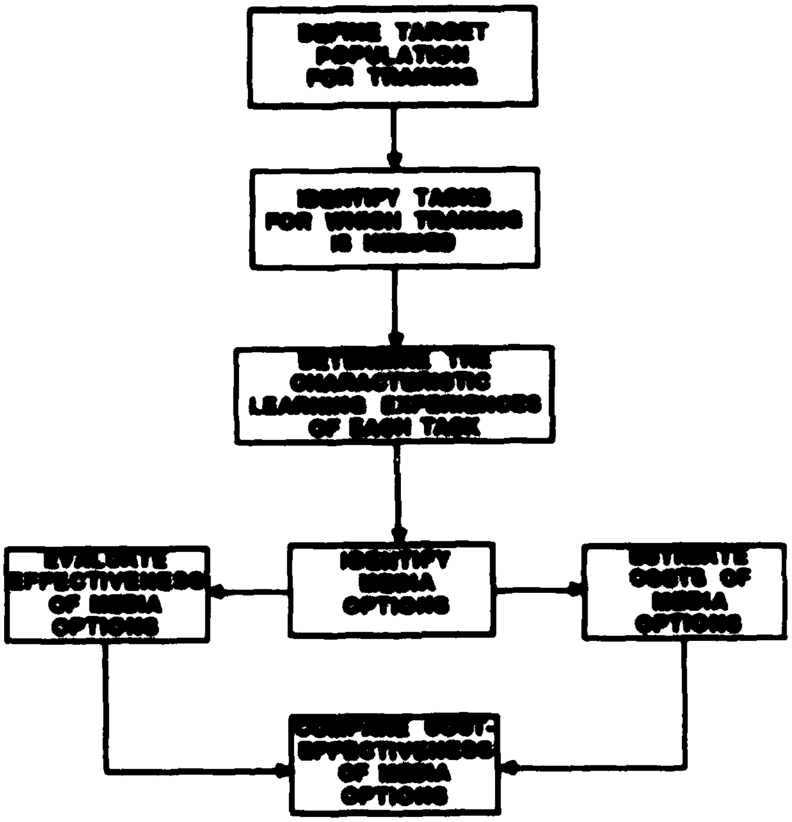

FIGURE 1. MEDIA SELECTION PROCEDURE

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[1] Selection of a "medium," or equivalently a "training device," implies selection of an encompassing "instructional system," in which courseware (which is the substance to be learned) and software (which calls up the courseware as needed and controls the medium according to an instructional strategy) are arranged to advantageously use capabilities of the medium (e.g., printed material, audio-visual equipment, videodisc, etc).

II. TRAINING ENVIRONMENT

Our initial study effort examined how Army RC training needs are shaped by the RC environment. We want to describe statistically the principal characteristics of that environment--viz., training time, geographic dispersion, and facility suitability--so that their impact on the utility and cost of training devices and procedures can be measured.

After receiving basic training of 8 weeks and initial skill level training of varying length--from several weeks to more than a year depending on the military occupational specialty (MOS)--by the same institutional training process used for their Active Army counterparts, Reservists and Guardsmen join their RC units, where they receive training to refresh and improve their skills.

A general idea of the overall problem of sustainment and unit training in the Army RCs is conveyed by some aggregate statistics: More than 600,000 soldiers with over 400 MOSs in approximately 6,900 units[1] at nearly 4,000 stations (Guard armories and Reserve centers). More specifically, the Army National Guard (ARNG) has 3,457 units and 2,858 armories; the average armory accommodates 148 enlisted personnel. The Army Reserve (USAR) has 3,438 units and 1,098 reserve centers; the

[1] A "unit" is a battalion or equivalent-level organization or a company, battery, platoon, detachment, or team, which is not an organic element of a battalion.

average population per center is 202 enlisted personnel. In both the ARNG and the USAR, many armory/center populations reflect a variety of MOSs, few billets of any single MOS, and few experienced instructor NCOs (non-commissioned officers). And in both the ARNG and the USAR during 11 months of the year, the RC soldier availability for training (2 days/month) is 10 percent of the 20 days/month availability of his Active Army counterpart; it is 50 percent for the month in which the Reservist/Guardsman is on 2-week active duty.

In order to determine the effect of environmental factors on Army RC training, a sample of MOSs was selected for examination in a two-step process. Table 1 shows the current authorized strengths, by component, of the 32 career management fields (CMFs), that the Army has established to administer clusters of related MOSs. In the first step in selecting our MOS sample, 13 of these CMFS were found to have combined ARNG and USAR populations greater than the corresponding active Army populations. Second, after arbitrarily replacing CMF 97, Band, by CMF 31, Communications Electronic Operations (because of the greater expected utility in combat of CMF 31), the largest population MOS in each of the 13 large-population CMFs was selected for the study sample; Table 2 indicates that these 13 MOSs account for between one-third and one-half of the populations of each Army component.

Density distributions of the large-population MOS sample were developed by an IDA computer program that aggregated authorized strengths and calculated average populations (i.e., authorized strength populations) from personnel data from the Army's PERSACS (Personnel Strength and Composition System) data base. The data are valid for the end of FY 1985. The dispersed nature of the RC environment is illustrated by Tables 3 through 7, which show the number of stations and the average populations for skill levels 1 through 5,[1] respectively, for the 13 MOSs.[2]

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[1] Skill level identifies skills, proficiency, or ability--level of qualification--typically required for successful performance at the grade with which the skill level is associated. Levels of qualification are identified by the numbers "0" through "5". Skill level "0" is used with an MOS to identify personnel undergoing training for award of a primary MOS. The following relationship exists between skill level (sl) and grade: sl 1 ~ E3 and E4; sl 2 ~ E5; sl 3 ~ E6; sl 4 ~ E7; sl 5 ~ E8 and E9 (Ref. 2).

[2] The component population for any MOS in Table 2 will differ slightly from the sums of populations of any MOS in Tables 3 through 7, where average population was rounded to the nearest whole number.

TABLE 1. CURRENT AUTHORIZED STRENGTH BY CAREER MANAGEMENT FIELD

CMF		ACTIVE	GUARD	RESERVE
11	INFANTRY	67,178	66,401	18,311
12	COMBAT ENGINEERING	16,898	23,265	10,154
13	FIELD ARTILLERY	38,735	34,285	5,846
16	AIR DEFENSE ARTILLERY	13,577	4,737	24
18	SPECIAL OPERATIONS	3,145	1,145	1,406
19	ARMOR	26,493	23,324	5,078
23	AIR DEFENSE SYSTEMS MAINTENANCE	2,655	66	7
27	LAND COMBAT AND AIR DEF INTERMED MAINT	4,589	838	83
28	AVIATION COMM-ELEC SYSTEM MAINTENANCE	1,927	692	250
29	COMM-ELEC MAINTENANCE	11,579	3,536	1,749
31	COMM-ELEC OPERATIONS	50,714	32,349	10,876
33	EW/INTELL SYSTEMS MAINTENANCE	1,493	33	167
51	GENERAL ENGINEERING	12,018	12,633	12,579
54	CHEMICAL	7,672	4,406	5,300
55	AMMUNITION	5,409	1,912	2,768
63	MECHANICAL MAINTENANCE	62,204	50,785	20,430
64	TRANSPORTATION	23,018	18,237	14,668
67	AIRCRAFT MAINTENANCE	16,754	8,484	2,326
71	ADMINISTRATION	44,870	20,060	33,036
74	AUTOMATIC DATA PROCESSING	4,623	1,183	923
76	SUPPLY AND SERVICE	40,741	26,616	24,634
79	RECRUITMENT AND REENLISTMENT	5,078	586	651
81	TOPOGRAPHIC ENGINEERING	1,297	433	870
84	PUBLIC AFFAIRS AND AUDIO-VISUAL	2,458	1,025	1,386
91	MEDICAL	39,774	18,272	30,267
92	PETROLEUM	7,397	4,266	2,796
93	AVIATION OPERATION	2,843	836	228
94	FOOD SERVICE	17,736	16,184	9,632
95	LAW ENFORCEMENT	22,918	13,074	7,599
96	MILITARY INTELLIGENCE	6,947	1,849	3,117
97	BAND	2,510	2,178	687
98	ELECTRONIC WARFARE/CRYPTOLOGIC OPERATIONS	8,311	33	1,070
	TOTAL	575,561	393,723	228,918

Source: PERSACS (Ref. 3)

TABLE 2. LARGE POPULATION MOSs

MOS	CMF	TITLE	COMPONENT POPULATION ACTIVE	GUARD	RESERVE
11B	11	INFANTRYMAN	47,808	45,161	16,321
12B	12	COMBAT ENGINEER	12,491	18,953	8,726
13B	13	CANNON CREWMEMBER	20,592	22,056	4,324
19E	19	M48-M60 ARMOR CREWMEMBER	12,780	12,916	3,160
31K	31	COMBAT SIGNALLER	7,974	8,420	2,576
54E	54	NBC SPECIALIST	6,680	4,242	2,756
62E	51	HEAVY CONSTRUCTION EQUIP. OPERATOR	2,557	3,239	2,328
63B	63	LIGHT WHEEL VEHICLE MECHANIC	17,555	13,637	7,102
64C	64	MOTOR TRANSPORT OPERATOR	18,062	17,365	9,781
71L	71	ADMINISTRATIVE SPECIALIST	19,570	7,026	18,921
76Y	76	UNIT SUPPLY SPECIALIST	17,728	11,261	8,402
91A	91	MEDICAL SPECIALIST	12,322	9,479	6,511
94B	94	FOOD SERVICE SPECIALIST	17,736	16,184	9,632
		TOTAL	213,855	189,939	100,540
		PERCENTAGE OF COMPONENT	37	48	44

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TABLE 3. NUMBER OF STATIONS (N) AND AVERAGE POPULATIONS ($\overline{M}$) FOR SELECTED MOSs AND SKILL LEVEL 1

MOS	COMPONENT					
	ACTIVE		GUARD		RESERVE	
	N	$\overline{M}$	N	$\overline{M}$	N	$\overline{M}$
11B1	35	786	160	190	133	23
12B1	23	342	91	138	46	108
13B1	21	707	132	129	22	126
19E1	16	405	89	79	32	10
31K1	41	156	637	11	425	5
54E1	28	93	192	4	89	12
62E1	29	56	184	12	134	11
63B1	60	175	737	12	515	8
64C1	66	190	589	22	369	17
71L1	94	105	610	9	561	18
76Y1	86	91	764	7	622	6
91A1	47	244	426	22	194	33
94B1	60	158	753	11	543	8

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TABLE 4. NUMBER OF STATIONS (N) AND AVERAGE POPULATIONS ($\overline{M}$) FOR SELECTED MOSs AND SKILL LEVEL 2

MOS	COMPONENT					
	ACTIVE		GUARD		RESERVE	
	N	$\overline{M}$	N	$\overline{M}$	N	$\overline{M}$
11B2	76	94	172	43	61	21
12B2	24	90	87	42	29	46
13B2	23	96	117	19	20	17
19E2	16	183	88	37	17	10
31K2	32	49	341	4	107	2
54E2	48	56	513	4	281	3
62E2	32	29	138	8	105	8
63B2	58	59	627	5	392	4
64C2	55	52	330	8	210	9
71L2	176	23	169	5	313	8
76Y2	137	23	507	3	340	3
91A2	74	11	98	3	25	3
94B2	62	46	727	4	543	4

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TABLE 5. NUMBER OF STATIONS (N) AND AVERAGE POPULATIONS ($\overline{M}$) FOR SELECTED MOSs AND SKILL LEVEL 3

MOS	COMPONENT					
	ACTIVE		GUARD		RESERVE	
	N	$\overline{M}$	N	$\overline{M}$	N	$\overline{M}$
11B3	57	119	172	23	164	38
12B3	30	54	93	21	55	29
13B3	38	65	128	15	33	23
19E3	31	72	83	24	51	35
31K3	0	0	0	0	0	0
54E3	51	27	530	2	285	2
62E3	0	0	0	0	0	0
63B3	65	29	487	3	333	2
64C3	96	20	322	5	172	7
71L3	118	24	106	3	240	8
76Y3	138	36	743	4	588	4
91A3	0	0	0	0	0	0
94B3	64	46	687	4	530	3

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TABLE 6. NUMBER OF STATIONS (N) AND AVERAGE POPULATIONS ($\overline{M}$) FOR SELECTED MOSs AND SKILL LEVEL 4

	COMPONENT					
	ACTIVE		GUARD		RESERVE	
MOS	N	$\overline{M}$	N	$\overline{M}$	N	$\overline{M}$
11B4	67	58	194	10	219	18
12B4	36	24	99	9	53	16
13B4	38	27	129	6	34	13
19E4	34	34	64	9	48	18
31K4	0	0	0	0	0	0
54E4	63	14	275	2	209	2
62E4	0	0	0	0	0	0
63B4	64	25	493	2	353	2
64C4	55	14	201	2	137	3
71L4	123	16	98	3	257	5
76Y4	116	15	471	2	371	3
91A4	0	0	0	0	0	0
94B4	65	34	683	3	521	3

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TABLE 7. NUMBER OF STATIONS (N) AND AVERAGE POPULATIONS ($\overline{M}$) FOR SELECTED MOSs AND SKILL LEVEL 5

	COMPONENT					
	ACTIVE		GUARD		RESERVE	
MOS	N	$\overline{M}$	N	$\overline{M}$	N	$\overline{M}$
11B5	77	33	190	7	209	8
12B5	0	0	0	0	0	0
13B5	0	0	0	0	0	0
19E5	0	0	0	0	0	0
31K5	0	0	0	0	0	0
54E5	0	0	0	0	0	0
62E5	0	0	0	0	0	0
63B5	25	4	28	1	34	2
64C5	0	0	0	0	0	0
71L5	123	7	74	3	167	20
76Y5	1	1	0	0	0	0
91A5	0	0	0	0	0	0
94B5	42	7	105	1	140	2

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III. MEDIA SELECTION

Our progress report on media selection is presented in the same sequence as the media selection procedure outlined in Figure 1.

A. TRAINING TARGET POPULATIONS

Three bases are used for selecting target populations for training. First, the large-population MOSs used to develop density distributions also provide target populations for gauging the cost-effectiveness of alternative training devices and procedures. Second, since some important technologies available for training might not be appropriate for the large-population MOSs, other MOSs that are associated with current or soon-to-be-available training devices that reflect advanced technologies may be selected. And third, special attention will be given to maintenance MOSs inasmuch as many RC soldiers repair or service trucks, armored vehicles, helicopters, electrical and electronic equipment, and weapons of all kinds. Table 8 shows that the current authorized strength of combat service support, which includes maintenance personnel, is especially heavy in the Reserve. For our sample set of 13 MOSs, 23 percent (MOSs 11B, 13B, and 19E) are in combat arms; 31 percent (MOSs 12B, 31K, 54E, and 62E) are in combat support; and 46 percent (MOSs 63B, 64C, 71L, 76Y, and 94B) are in combat service support.

TABLE 8. CURRENT ARMY AUTHORIZED STRENGTH--POPULATION FRACTIONS BY FUNCTION [a]

FUNCTION \ COMPONENT	ACTIVE	GUARD	RESERVE
COMBAT ARMS[b]	0.31	0.34	0.15
COMBAT SUPPORT[c]	0.25	0.24	0.23
COMBAT SERVICE SUPPORT[d]	0.44	0.42	0.62
TOTALS	1.00	1.00	1.00

[a] Source: PERSACS (Ref. 3)

[b] Includes CMFs 11, 13, 16, 18, 19, 23, 27, 67, and 93.

[c] Includes CMFs 12, 28, 29, 31, 33, 51, 54, 81, 95, 96, 98, and part of CMF 74 (MOSs 34C, -F, -H, -K, -L, -T, -Y, and -Z).

[d] Includes CMFs 55, 63, 64, 71, 76, 79, 84, 91, 92, 94, 97, and part of CMF 74 (MOSs 74D, -F, and -Z).

B. TASK IDENTIFICATION

An MOS designation implies that a soldier has certain skills, each of which implies abilities to perform a set of tasks. Each MOS typically encompasses several dozen tasks, which are identified in a "Soldier's Manual," where each task is typically composed of multiple subtasks. For skill level 1 soldiers in our 13-MOS sample, the average number of tasks per MOS is 71. As an example of the types of tasks that are associated with an MOS, Tables 9 and 10 indicate, respectively, the common tasks and those specifically related to the M101A1 (105mm towed howitzer) for a skill level 1 Cannon Crewmember, MOS 13B (Ref. 4). Tables 11, 12, and 13 indicate the common tasks and the M101A1 specific tasks for MOS 13B skill levels 2, 3, and 4, respectively.

C. CHARACTERISTIC LEARNING EXPERIENCES

Learning is generally categorized as either cognitive or psychomotor in nature. Cognitive learning includes memorization, rule learning, rule using, identification and classification, and making decisions. Psychomotor learning includes skill mastery and positioning movements. Many tasks require both types of skills.

Experiments and experience in learning indicate that, to provide equal training effectiveness, tasks with increased complexity and length of the cognitive or psychomotor aspects require increased training and practice.

In order to estimate the effectiveness of alternative media for learning MOS tasks, the cognitive and psychomotor elements of these tasks have to be identified. Whatever measured results of learning experiments and experience are available will then provide a basis for estimating media effectiveness on the common denominators, viz., cognitive learning and pyschomotor learning, of the MOS tasks.

TABLE 9. COMMON TASKS FOR MOS 13B SKILL LEVEL 1

CANNONEER

- PREPARE A POSITION TO RECEIVE/EMPLACE A HOWITZER
- RECORD/MAINTAIN FIRE MISSION DATA ON DA FORM 4513
- EMPLACE/RECOVER COLLIMATOR
- EMPLACE/RECOVER AIMING POSTS

AMMUNITION

- LOAD HOWITZER AMMUNITION ON VEHICLES
- STORE AMMUNITION IN PREPARATION FOR FIRING

CREW-SERVED WEAPONS

- PERFORM OPERATOR MAINTENANCE ON A M60 MACHINE GUN AND AMMUNITION
- PREPARE A RANGE CARD FOR A M60 MACHINE GUN
- PERFORM OPERATOR MAINTENANCE ON A CALIBER .50 MACHINE GUN AND AMMUNITION
- LOAD, REDUCE A STOPPAGE, UNLOAD, AND CLEAR A CALIBER .50 MACHINE GUN
- ENGAGE TARGETS WITH A CALIBER .50 MACHINE GUN
- SET HEADSPACE AND TIMING ON A CALIBER .50 MACHINE GUN
- MOUNT/DISMOUNT A CALIBER .50 MACHINE GUN

COMBAT TACTICS

- INSTALL AND OPERATE FIELD TELEPHONE

NAVIGATION

- DETERMINE THE ELEVATION OF A POINT ON THE GROUND USING A MAP
- DETERMINE AN AZIMUTH USING A M2 COMPASS

COMMUNICATIONS

- USE VISUAL SIGNALS TO CONTROL MOVEMENT

CANNON MAINTENANCE

- PREPARE DA FORM 2404 (EQUIPMENT INSPECTION AND MAINTENANCE WORKSHEET)

TABLE 10. M101A1 TASKS FOR MOS 13B SKILL LEVEL 1

CANNONEER

- PREPARE SEMIFIXED AMMUNITION FOR FIRING
- BORESIGHT THE DIRECT FIRE TELESCOPE USING A DISTANT AIMING POINT
- BORESIGHT THE DIRECT FIRE TELESCOPE USING A TESTING TARGET
- SET/LAY THE CANNON FOR QUADRANT WITH THE RANGE QUADRANT
- MEASURE THE QUADRANT WITH THE RANGE QUADRANT
- SIGHT ON A TARGET WITH THE DIRECT FIRE TELESCOPE
- DISASSEMBLE/ASSEMBLE BREECH AND FIRING MECHANISM
- LOAD AND FIRE A PREPARED ROUND

CANNON MAINTENANCE

- PERFORM PREVENTIVE MAINTENANCE CHECKS AND SERVICES

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TABLE 11. TASKS FOR MOS 13B SKILL LEVEL 2

COMMON TASKS

GUNNER

- REFER THE PIECE

NAVIGATION

- CONVERT AZIMUTHS (MAGNETIC OR GRID)
- MEASURE AN AZIMUTH ON A MAP WITH A PROTRACTOR

M101A1 TASKS

GUNNER

- ALIGN AIMING POSTS
- ALIGN COLLIMATOR
- LAY A HOWITZER FOR INITIAL DIRECTION OF FIRE BY RECIPROCAL LAY
- LAY A HOWITZER FOR INITIAL DIRECTION OF FIRE
- BORESIGHT THE PANORAMIC TELESCOPE USING A DISTANT AIMING POINT (DAP)
- BORESIGHT THE PANORAMIC TELESCOPE USING A TESTING TARGET
- SET/LAY THE HOWITZER FOR DEFLECTION
- SIGHT ON A TARGET DURING DIRECT FIRE WITH THE PANORAMIC TELESCOPE

TABLE 12. TASKS FOR MOS 13B SKILL LEVEL 3

COMMON TASKS

CHIEF OF SECTION

PREPARE A HOWITZER FOR FIRING
DETERMINE SITE AND RANGE TO CREST
PERFORM GUNNER'S QUADRANT MICROMETER TEST
PERFORM GUNNER'S QUADRANT END-FOR-END TEST
PREPARE A RANGE CARD FOR A HOWITZER
DETERMINE THAT THE HOWITZER IS SAFE TO FIRE
COMPUTE DATA FOR SWEEP AND ZONE FIRE MISSION
SET/LAY FOR QUADRANT WITH GUNNER'S QUADRANT
ISSUE FIRE ORDER FOR DIRECT FIRE MISSION

CANNON MAINTENANCE

MAINTAIN DA FORM 2408-4 (WEAPON RECORD DATA)

NAVIGATION

LOCATE AN UNKNOWN POINT ON A MAP OR ON THE GROUND BY INTERSECTION
LOCATE AN UNKNOWN POINT ON A MAP OR ON THE GROUND BY RESECTION

M101A1 TASKS

CHIEF OF SECTION

TAKE IMMEDIATE ACTION FOR MISFIRE (SEMIFIXED AMMUNITION)

CANON MAINTENANCE

ADJUST THE EQUILIBRATORS
PERFORM PREFIRE CHECKS

TABLE 13. COMMON TASKS FOR MOS 13B SKILL LEVEL 4

CHIEF OF FIRING BATTERY/GUNNERY SERGEANT

- SET UP/RECOVER THE M2 AIMING CIRCLE
- ESTABLISH THE AZIMUTH OF THE ORIENTING LINE (OL) USING SIMULTANEOUS OBSERVATION
- ESTABLISH THE AZIMUTH OF THE ORIENTING LINE (OL) USING THE POLARIS-KOCHAB METHOD
- ESTABLISH THE AZIMUTH OF THE ORIENTING LINE (OL) USING DIRECTIONAL TRAVERSE
- DETERMINE LOCATION BY GRAPHIC RESECTION
- LAY THE FIRING BATTERY USING THE M2 AIMING CIRCLE BY THE ORIENTING ANGLE METHOD
- LAY THE FIRING BATTERY USING THE M2 AIMING CIRCLE BY THE GRID AZIMUTH METHOD
- LAY THE FIRING BATTERY USING THE M2 COMPASS
- LAY THE FIRING BATTERY USING THE AIMING POINT AND DEFLECTION METHOD
- LAY THE FIRING BATTERY USING THE HOWITZER BACK-LAY METHOD
- MEASURE THE ORIENTING ANGLE
- MEASURE THE AZIMUTH
- MEASURE PIECE-TO-CREST RANGE (PCR)
- COMPUTE EXECUTIVE OFFICER'S (XO) MINIMUM QUADRANT ELEVATION (MIN QE) USING RAPID FIRE TABLES
- MEASURE DISTANCE USING THE SUBTENSE METHOD
- PREPARE/SUBMIT EXECUTIVE OFFICER'S (XO) REPORT

CANNON MAINTENANCE

- PERFORM FIRE CONTROL ALIGNMENT TESTS (M101A1)
- PERFORM FIRE CONTROL ALIGNMENT TESTS (M102)
- PERFORM FIRE CONTROL ALIGNMENT TESTS (M114A1)
- PERFORM FIRE CONTROL ALIGNMENT TESTS (M109-SERIES)
- PERFORM FIRE CONTROL ALIGNMENT TESTS (M198)
- PERFORM FIRE CONTROL ALIGNMENT TESTS (M110-SERIES)

Of the average 71 tasks per MOS (skill level 1) in the 13-MOS sample, 68 tasks involve both cognitive and psychomotor learning; two involve only cognitive learning; and one involves only psychomotor learning.

D. MEDIA OPTIONS

Two groups of media are being examined: (1) media currently used by the Army and (2) new media devices that embody advanced technology.

1. Current Media

The Army Training and Doctrine Command (TRADOC) identifies nine categories of extension training materials[1], which are indicated in Table 14, for all components--Active, Guard, and Reserve. A TRADOC-provided listing for the 13 sample MOSs contains approximately 2400 items among these nine categories. A TRADOC catalog relating these materials to tasks has reportedly been completed, but is not yet available for distribution.

While the cost and effectiveness of all extension training materials are of interest, the focus of this investigation is primarily on training devices.

2. New Technology

Embedded trainers, artificial intelligence, computer-based instruction, interactive television, interactive videodiscs, and telecommunications are only a partial list of new technology opportunities for Army training.

While other hardware and software examples of new technology might also be mentioned, it seems most logical for

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[1] For sustainment and unit training vis-a-vis institutional training.

TABLE 14. EXTENSION TRAINING MATERIALS

- TRAINING LITERATURE PRODUCTS: BOOKS, SOLDIER'S MANUALS
- TRAINING EXTENSION COURSES: AUDIOVISUAL, AUDIO, SLIDES, PRINTED LESSONS
- AUDIOVISUAL: TRAINING VIDEO TAPE OR PROJECTOR
- GRAPHIC TRAINING AIDS: BOOKLETS, CHARTS, CARDS, SLIDES, GAMES
- DEVICES: TO SUPPORT UNIT TRAINING
- SKILL PERFORMANCE AIDS: TECHNICAL MANUALS WITH LOTS OF GRAPHICS
- CORRESPONDENCE COURSES
- RESIDENT EXPORTABLE MATERIAL: FOR RESIDENT INSTRUCTION AND SUPPORT OF UNIT TRAINING
- RESERVE COMPONENT SCHOOL MATERIALS

this study to investigate a set of topical training devices that incorporate some types of new technology that appear particularly relevant to the RC training environment. Table 15 lists several candidates for cost-effectiveness investigation.

E. MEDIA EFFECTIVENESS

Our analyses of effectiveness and costs will use Army analyses wherever possible. As a prerequisite for development of a training device, the Army performs a Cost and Training Effectiveness Analysis (CTEA) to support a system training device requirement or a Training Development Study (TDS) to support a nonsystem training device requirement.[1]

A CTEA or a TDS contains a training device cost-effectiveness analysis and analyses of other factors as well: (1) new skills and knowledge needed to operate and maintain the device, (2) suitability of the device to train the target population, (3) changes to the current training programs to make best use of the device, (4) development of a new training program, (5) changes to training facilities, and (6) compatibility of the proposed device with existing systems (Ref. 5).

Reviews of CTEAs and TDSs will provide opportunities to examine information used by the Army in its training investment analyses. Where necessary, we expect to perform independent effectiveness analyses.

Our consideration of new technologies persuades us that interactive video and telecommunications would be especially well-suited for delivering quality-controlled, standardized training to geographically dispersed locations. Interactive video, with tape or disc storage, can show step-by-step operating, servicing, or repair processes with detailed two or three-dimensional graphics that depict a training object

[1] This prerequisite is sometimes waived.

TABLE 15. SOME NEW TECHNOLOGY DEVICES

- MAINTENANCE TRAINING SIMULATORS
- INTERACTIVE VIDEODISC DEVICES - ELECTRONIC INFORMATION DELIVERY SYSTEM (EIDS)
- INTERACTIVE TELEVISION TRAINER VIA SATELLITE - SCHOOL OF THE AIR
- LASER ENGAGEMENT SYSTEM (MILES)
- INTERACTIVE SIMULATOR NETWORKING - SIMNET
- INTERACTIVE SIMULATION TRAINERS - GUARD FIST I (ARMOR) AND GUARD FIST II (ARTILLERY)
- COMPUTER-BASED VISUAL GUNNERY SIMULATOR - CONDUCT OF FIRE TRAINER (COFT)
- VIDEODISC GUNNERY SIMULATOR (VIGS)
- TANK GUNNERY AND MISSILE TRACKING SYSTEM (TGMTS)

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from any view with any level of detail. Feedback and control capabilities of interactive video systems can give the viewer the perception of active participation in the operating, servicing, or repair process, even though he or she controls the training device but not the training object (which might be actual equipment or a model).

With training by telecommunications, expert, charismatic instructors could simultaneously teach several dispersed groups. Arrangements could be made for student-instructor interaction as in the Army's "School of the Air" concept.

While there seems to be general agreement among professionals concerned with learning--instructional system designers, behavioral psychologists, training managers, and teachers--that interactive video and telecommunications hold great promise as training technologies, a number of tests and analyses are needed in selecting either medium for a specific application. These tests and analyses would facilitate such design choices as "Interactive video or telecommunications?" and "If interactive video, tape or disc storage?" and compare training effectiveness of the new technology choice with that of current media.

F. MEDIA COSTS

Our cost analysis involves (1) collecting generic cost data, (2) collecting cost estimates of specific training systems, and (3) using both sets of data to develop simple predictive models of the relative costs of alternative training strategies. Our effort so far has been devoted to the first two tasks.

1. Generic Costs

Our cost structure provides for these major cost categories of a training system: research and development (R&D) costs, investment costs, and operating and support costs. Elements of these categories and the general sources of cost data are indicated in Table 16. Costs for these elements are being collected from three source categories: (1) hardware and software costs related to advanced technology equipment; (2) forecast costs related to advanced technology equipment; and (3) costs of similar items that are now, or will soon be, available commercially.

a. R&D. The R&D cost category contains the element "Hardware R&D" and other elements, which collectively are labeled "instructional system development (ISD)." We have not yet collected any Hardware R&D cost data.

Man-hour and cost estimates of courseware development, one of the ISD elements, are shown in Table 17 (from Ref. 6). The estimates are based on a cost rate of $50, in FY 1986 dollars, per person per hour. Some estimates (e.g., those for interactive computer-aided instruction) are based on advances in other related fields. However, they are particularly valuable as indicators of the relative costs of various advanced technology devices.

To compare advanced technology systems to current systems, man-hour and cost data from a Navy study (Ref. 7) are also presented as "existing technology" in Table 17. These latter data, which have been modified to separate design costs and development costs and to reflect organizational overhead, indicate the costs (in FY 1986 dollars) incurred in the ISD process by the Navy in the late 1970s. While the comparison of two sets of estimates developed separately must be undertaken with care, a ratio of about 5:1 for course development using advanced technology training devices rather than existing technology appears reasonable based on data collected so far.

b. Investment. General statements about the procurement costs of advanced technology training systems can be misleading for two reasons. First, there are a wide variety of different

TABLE 16. AGGREGATE COST BREAKDOWN STRUCTURE

- RESEARCH AND DEVELOPMENT (R&D) COSTS

  --HARDWARE R&D
  --INSTRUCTIONAL SYSTEM DEVELOPMENT (ISD)

    -Task Analysis[1]
    -Course Design[1]
    -Course Development[2]

- INVESTMENT COSTS

    -Equipment Procurement[1,3]

- OPERATING AND SUPPORT COSTS

    -Student pay and allowances based on course length[1]
    -Instructor pay and allowances based on requirements and preparation time
    -Equipment operations and maintenance (O&M)
    -Facilities O&M

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[1] Estimates for similar existing systems.

[2] Predicted costs for advanced technology systems.

[3] Commercial items.

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TABLE 17. TRAINING DELIVERY SYSTEM, COURSEWARE DEVELOPMENT COST ESTIMATES

TECHNOLOGY	DEVELOPMENT HOURS PER HOUR OF INSTRUCTION	DEVELOPMENT COST PER HOUR OF INSTRUCTION (IN 1000's OF $)
ADVANCED	(MEAN = 570)[1]	(MEAN = 29)[1]
COMPUTER-AIDED INSTRUCTION	100-400	5-20
INTERACTIVE COMPUTER-AIDED INSTRUCTION	500-1000	25-50
INTERACTIVE VIDEODISC	400-800	20-40
SIMULATORS	800-2000	40-100
EMBEDDED TRAINING	200-300	10-15
ADVANCED JOB PERFORMANCE AIDS	40-300	2-15
EXISTING	(MEAN = 170)[2]	(MEAN = $5)[2]
MEDIA, CIRCA 1980	65-450	2-14

[1] ARITHMETIC MEAN
[2] EMPIRICAL MEAN

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systems with different equipment requirements. Second, some of these systems are just becoming operational (e.g., videodisc) or are still in development (e.g., intelligent computer-aided instruction). However, some insight is available both from the general literature and from specific programs under development.

Interactive videodisc is a technology that is expected to be very important in future Army training programs. The training medium will be an EIDS (Electronic Information Delivery System) unit, which consists of a videodisc player and a microcomputer or microprocessor that performs input, memory, data-processing, and output functions. The Army expects that the average unit cost of a large EIDS procurement will be about $4000 in FY 1986 dollars. The significance of this unit cost is that EIDS or systems like it are expected to be the main equipment of numerous future training devices.

While simulators usually range in cost from 20-65 percent of actual equipment costs (Refs. 8 and 9), a similar rule of thumb for the cost of computer-based instruction is more elusive (Ref. 10).

Table 18 shows some investment estimates that are based on costs of commercially available equipment. Many of the postulated computer-based training delivery systems are direct spin-offs of commercially available, or soon-to-be available, equipment. The main point here is that technology transfer from the commercial sector can provide low-cost, highly capable equipment that is well-suited for the dispersed populations and low equipment utilization rates of the Army RC training environment.

The last item in Table 18 is a key to understanding the possibilities for obtaining inexpensive hardware, and for gaining insight on future hardware, software, and courseware tradeoffs. Simply stated, the price of a given level of computing power has fallen 20-25 percent a year every year for the last 30 years. But software and courseware productivity growth is reported at 4 percent per year (Ref. 11). This

TABLE 18. INVESTMENT COSTS - COMMERCIALLY AVAILABLE EQUIPMENT

- COMPUTER HARDWARE MORE THAN CAPABLE OF PERFORMING THE FUNCTIONS OF AN EIDS[1] (WITHOUT VIDEODISC) IS AVAILABLE COMMERCIALLY FOR $5,000-10,000[2]
- CD-ROM (COMPACT DISK - READ ONLY MEMORY) VIDEODISC WILL BE AVAILABLE IN 1986 FOR $500[3]
- MASTERING CD-ROM DISCS CURRENTLY COSTS $5000[4] TO $8000[5], AND COPIES ARE $5[4] OR LESS
- HISTORICALLY, HARDWARE PRICES HAVE FALLEN BETWEEN 20%[6] AND 50%[7] ANNUALLY FOR GIVEN CAPACITY (WITH 25% A COMMONLY-USED AVERAGE)

[1] EIDS = ELECTRONIC INFORMATION DELIVERY SYSTEM
[2] FULLY-CONFIGURED, HIGH-END MICROCOMPUTER
[3] REF. 12.
[4] REF. 13.
[5] REF. 14.
[6] REF. 15.
[7] REF. 16.

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means that, for a fixed system, software will become the primary cost-driver. To achieve lower cost systems, future designs may see trade-offs of hardware for software.

c. Operating and Support. Operating and support costs are a key component of the total life-cycle cost of a training system. Much of the overall savings expected from advanced technology training devices is based on decreases in course length or instructor requirements and consequently less total pay for students and instructors.

Table 19 shows some operating and support cost estimates that are available from the literature. For training systems still under development, these costs are not known with certainty. For earlier versions of computer-aided instruction (CAI) and simulators, estimates of cost savings are about 30 percent in comparison to conventional instruction (Refs. 9 and 17). The majority of these savings come from the introduction of individualized instruction embodied in the delivery system and not from the existence of the computerized instruction alone (Ref. 17).

Total instructor requirements fall with decreased course length, all other things being equal. The incorporation of subject matter expertise into computers and/or simulators should also result in less instructor time per student hour, but the evidence is fragmentary and not conclusive.

Savings on other operating and support costs may result in significant life-cycle cost differences between training options. For example, the O&S costs of flight simulators are 8-10 percent of the cost of operating the aircraft being simulated (Ref. 18).

Table 20 indicates the data and analysis that are still needed in our investigation of generic costs. An important finding in our data search is that there is a lack of cost data on computer-based training (CBT) devices. This circumstance is

TABLE 19. OPERATING AND SUPPORT COSTS

- CHANGES IN STUDENT PAY AND ALLOWANCES DUE TO SHORTER COURSE LENGTHS
  - Not available for many advanced technology systems
  - Previous comparisons of computer-aided and computer-managed instruction show 30% time savings; similar savings for maintenance simulators
  - Further analysis suggests 90% of savings come from individualized instruction, not CAI, and possibly not simulators
- CHANGES IN INSTRUCTOR PAY AND ALLOWANCES DUE TO CHANGING REQUIREMENTS AND PREPARATION TIME
  - Total requirements vary with course length
- OTHER OPERATING AND SUPPORT COSTS
  - For flight simulators, O&S costs are 8-10% of O&S for the aircraft being simulated

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TABLE 20. COST ANALYSIS NEEDS

- COMPLETE COST DATA NEEDED
  - -Development cost
    - --Task analysis, design, development--an expanded, up-to-date version of Instructional Program Development Center work for all services
  - -Acquistion costs--for enough specific systems that generic cost estimates can be made
  - -Operating costs
    - --Course length changes due to the partial effect of advanced technology
    - --Effects of systems on instructor requirements
    - --Better understanding of equipment and facilities O&M
- DEVELOP MODEL TO PRODUCE RELATIVE COSTS OF ALTERNATIVE MEDIA/ SYSTEM CHOICES

due in part to the relatively recent introduction of CBT (compared to weapon systems in which computers are critical elements) and in part to the fact that much of the work is done within existing budget categories, which, because of cost aggregation, preclude identifying CBT costs. Past findings of a similar nature have resulted in a proposed cost taxonomy to correct these cost analysis problems (see Ref. 19).

Large cost elements and areas of potentially large cost differences are highlighted in Table 20. Our current weakness in cost data will be somewhat corrected as specific devices, such as, M-COFT and Guardfist 2, the only specific devices on which we now have cost data, are analyzed.

2. Costs of Specific Devices

Some of the costs that are being developed for specific training devices are contained in Tables 21 and 22, where cost per unit, cost per trainee, and life-cycle cost are shown for the Mobile Conduct of Fire Trainer (M-COFT) and the Guard Unit Army Device (Guard) Full Crew Interactive Simulation Trainer (Fist) for Artillery (Guardfist 2).[1] The cost estimates were adjusted to FY 1986 constant dollars using OSD-Comptroller[2] inflation indices (Ref. 24). Life-cycle cost per trainee is an average, undiscounted cost divided by the number of personnel slots (or billets), each of which is assumed filled by a soldier-trainee, in the table of organization and equipment of the unit using the device. Operating and support costs are based on an equipment life of 20 years.

The M-COFT is a trailer-mounted version of the COFT, a gunnery simulator that trains tank commanders and gunners of main battle tanks and Bradley fighting vehicles. The M-COFT uses computer-based visual simulation technology to produce

[1] Data sources are Refs. 20-23.
[2] OSD = Office of the Secretary of Defense.

TABLE 21. LIFE-CYCLE COSTS FOR MOBILE CONDUCT OF FIRE TRAINER (CONSTANT FY 86 DOLLARS IN THOUSANDS)

	UNIT COSTS M-COFT VARIANT		
	MAIN BATTLE TANK, M-1	FIGHTING VEHICLES, M-2/M-3	MAIN BATTLE TANK, M60
RESEARCH & DEVELOPMENT	-	-	-
INVESTMENT	$2,600	$1,810	$2,660
OPERATING & SUPPORT*	$4,760	$4,760	$4,760
LIFE-CYCLE COSTS (LCC)*	$7,360	$6,570	$7,420
MOS TRAINED	19K	11M/19D	19E
BASIS OF ISSUE	ONE PER ARNG ARMOR BATTALION	ONE PER ARNG MECHANIZED INFANTRY BATTALION	ONE PER ARNG AND USAR ARMOR BATTALION AND USAR TRAINING DIVISION
NUMBER FUNDED BY FY 1986/AFTER FY 86	7/0	6/0	11/37
LCC PER TRAINEE	$32.3	$15.0	$31.4

* BASED ON A 20 YEAR EQUIPMENT OPERATIONAL LIFE

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TABLE 22. LIFE-CYCLE COST FOR GUARDFIST 2 (CONSTANT FY86 DOLLARS IN THOUSANDS)

	TOTAL COST	UNIT COST
RESEARCH & DEVELOPMENT	$ 9,240	$ 26
INVESTMENT	$11,700	$ 32
OPERATING & SUPPORT*	$33,730	$ 93
LIFE-CYCLE COSTS (LCC)**	$54,670	$151

MOS TRAINED — 13B,E,F

BASIS OF ISSUE — ONE PER FIELD ARTILLERY (FA) BATTALION, FA BRIGADE, DIVARTY, CORPS, AND INFANTRY/ARMOR BATTALION IN THE RESERVE COMPONENTS.

NUMBER FUNDED AFTER FY 1986 — 405 (INCLUDES 362 OPERATIONAL UNITS AND 43 SUPPLY/ MAINTENANCE UNITS FOR TRAINING SUPPORT)

LCC PER TRAINEE — $0.36

* PER OPERATIONAL UNIT

** BASED ON A 20 YEAR EQUIPMENT OPERATIONAL LIFE

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full-color action scenes in which the tank commanders and gunners practice operational procedures and target acquisition, identification, and engagement. The mobile adaptation of COFT, whose R&D cost of $28M is sunk, is designed to meet special needs of the ARNG.

The Guardfist 2 is a portable training device that will support individual training of artillery FOs (forward observers) and interactive training of all elements of the field artillery team--gun crew, fire direction center personnel, and FO. The device will present moving and stationary ground targets with realistic background scenes on a video monitor for the FO to call for and adjust indirect artillery and mortar fires. In addition to realistic background scenery, this interactive-video-based system can superimpose (on that scenery) targets and explosion graphics from its visual data bases. Full scale development of Guardfist 2 is expected to be completed by FY 1989.

Cost-per-trainee figures are based on the number of personnel in these specific battalions: (1) Tank Battalion equipped with M-1s, TOE[1] 17235J420, 228 personnel with MOS 19K; (2) Tank Battalion equipped with M60s, TOE 17235J410, 236 personnel with MOS 19E; (3) Mechanized Infantry Battalion equipped with Bradley fighting vehicles, TOE 072435J410, 438 personnel with 11M or 19D MOSs; and (4) Field Artillery Battalion, 155mm Towed Howitzer, TOE 06125H000, 419 personnel with MOSs 13B, 13E, and 13F.

The M-COFT (M-1 or M60) will be assigned to a battalion whose typical composition is four companies located at different and separate stations. Army utilization factors indicate that each company will require two weekends to provide M-COFT training sessions for all its personnel, after which the trainer will be towed to another company-station.

1 TOE = table of organization and equipment.

Thus, each 19K soldier (M-1) or 19E soldier (M60) would get six M-COFT training sessions per year. The \$31,000-\$32,000 cost over 20 years for a M-1 M-COFT or a M60 M-COFT means the total cost per trainee is about \$1,500 per year, or \$250 per training session.

We do not yet have cost estimates for Guardfist 1, a full crew tank gunnery simulator, which, like M-COFT, will provide procedural training for tank gunnery, and which, like the Guardfist 2 artillery device, will be based on interactive videodisc technology. But whereas Guardfist 2 uses a single videodisc system, the Guardfist 1 will include three videodisc systems--one each for the tank commander, the gunner, and the driver.

For a quick, conservative comparison of bottom-line costs of Guardfist 1 and M-COFT, let's suppose the 3:1 ratio of videodisc systems for Guardfist 1 and Guardfist 2 is used as a first order indicator of the relative life-cycle costs of these trainers. From Table 22, the life-cycle cost per operating unit for Guardfist 1 would be 3 x \$151K = \$453K. So LCC per trainee would be \$453K ÷ 236 soldier-trainees in an M60 tank battalion and \$453K ÷ 228 soldier-trainees in an M-1 tank battalion. These LCC-per-trainee figures of \$1919 and \$1987, for the M60 and the M-1, respectively, compare to \$31,400 and \$32,300 in Table 21 for M-COFT. The 16:1 advantage in LCC per trainee makes Guardfist 1 an attractive device for detailed cost-effectiveness analysis.

IV. FINDINGS

The density distributions of several large-population MOSs illustrate quantitatively the principal characteristic of the Army RC environment: a dispersion of many small training target populations.

Because of limited availability of Guardsmen and Reservists for training, low utilization is expected for training equipment in the Army RC environment.

Population dispersion plus low utilization of training equipment make low-cost-per-trainee a design imperative for Army RC training devices.

The capabilities and costs of interactive video make this equipment especially promising for RC training applications.

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23. "Baseline Cost Estimate for the Guard Fist II," PM-TRADE, October 1985.

24. "Department of Defense Deflators (Outlays)," 23 January 1985.

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